DECEREBRATION OF THE DOMESTIC FOWL.

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The decerebration of the pigeon has been successfully accomplished by numerous investigators. Rolando (1809), Flourens (1822), Munk (1883), Shrader (1889), Rogers (1916 and 1922-23), and others have contributed much to our knowledge of the operative technique and the resultant behavior of the decerebrate bird. Rolando (1809) showed that decerebrate pigeons could be kept alive for a long period of time after extensive destruction of the cerebrum, the birds exhibiting a sleep-like attitude until they were destroyed.

Flourens (1822) decerebrated pigeons and chickens. After the result of his experimental work, he concluded that the seat of intelligence, will, etc., was in the cerebrum; that the senses, reception and conveying of the sense impressions were entirely separate; e.g. the sense of sight in the corpora bigemina. The decerebrate animal could not use its senses because it lacked perception.

In contrast to these workers Shrader (1889) stated, "None of my observation birds have showed longer than the first three or four days, that sleep-like attitude." He observed that decerebrate pigeons did not feed since this act apparently depended on portions of the frontal brain or perhaps on parts of the middle brain.

Munk (1883) studying the functions of the cerebral cortex of pigeons states, "I cannot agree with the oft repeated recommendation to use young animals. I have had the best success with older pigeons and finally used older ones for the experiment. * * * * * * * * * I must give warning against preparing the birds through long starvation and thirst to decrease hemorrhage, because as a result of such procedure the animal has not enough resistance and easily collapses from weakness. It is enough to keep nourishment away for eighteen hours."

The ability of an apparently decerebrate bird to regain the complex reflexes of eating and drinking was studied by Munk (1883) and Shrader (1889). These workers concluded that basal parts of the corpora striata were present. In a recent

work, Rogers (1922-1923) states, "The following basal areas of the striatum were demonstrated histologically to be present, though reduced in size; meso-striatum and parts of the ekto-striatum and epi-striatum. These parts were connected with the thalamus and mid-brain by medullated fibres which, after death, were readily stainable, and seemed histologically to be normal. These parts were present in one hemisphere only, only traces of the other hemisphere being present."

In the present series of decerebrations, the method of operative procedure closely followed that of previous workers, the technique being modified slightly as occasion demanded. Extended over a period of two years, fifty-four birds were operated removing the cerebral hemisphere partially or completely. Fowls were selected that were about one year of age and free from disease. These were placed in cages 20″ x 20″ x 12″, each bird having a separate compartment.

OPERATIVE PROCEDURE.

Birds were fasted eighteen to twenty-four hours before operating. The hen was secured in a cloth sack, leaving the head and neck protruding. Squibb's anaesthetic ether was used to anaesthetize the bird. Feathers were plucked from the operative area from ear to ear and from the comb posteriorly to the first cervical vertebra. A transverse incision was made through the skin from ear to ear and the periosteum removed from the bones covering the cerebral hemispheres. Two holes were trephined over the center of each hemisphere, and with small bone forceps the openings were enlarged from before backwards and from side to side, care being taken not to injure the dura mater, also carefully avoiding the longitudinal sinus. The dura mater was slit antero-posteriorly, after applying a solution of codrenin (cocaine 2% solution, with adrenalin 1-15000) to control hemorrhage. Using a small spatula the cerebral hemispheres were lifted, care being taken not to injure the brain stem. After the hemispheres were removed, hemorrhage was checked by using pledgets of cotton moistened with codrenin. The control of hemorrhage is more of a problem in fowls than in pigeons, due to the larger blood supply to these parts in the former. No attempt was made to suture the dura mater or the skin, in fact the latter was purposely left unsutured, so that the blood clot would not cause pressure upon basal centers. No ill results occurred from

infection, because of the high resistance that birds possess. Direct observations were not made until three or four weeks elapsed, thus giving time for the disturbed parts to heal.

Since the fowl could be completely decerebrated and continue in health for one month, the question arose, how long could a decerebrate bird live. Three operated fowls were selected, their behavior indicating complete decerebration. Since the eating and drinking reflexes were destroyed, food and water were administered by forced feeding to these birds daily. Two were observed over a period of four months, before being destroyed and autopsied. The third bird was kept in health for eight months, at which time it was attacked and killed by a rat, thus putting an end to the observation.

BEHAVIOR OF DECEREBRATE BIRDS.

The behavior of the birds depends entirely upon whether the birds are partially or completely decerebrate. Immediately after the operation and for two or three days all birds show more or less shock. After this period, if the bird is only partially decerebrate, eating and drinking may be accomplished with some difficulty, the bird pecking at food much the same as young chicks do. Completely decerebrate hens present the typical picture given by similarly operated pigeons; sleepy attitude, head and neck drawn into body, feathers fluffed, with occasional stretching of neck and legs. If enclosed in a small cage scarcely any movements occur for hours. Placed in larger quarters, the birds would sometimes stand motionless for variable lengths of time, then suddenly move several steps. Never do they fall over obstructions purposely put in their paths. There seemed to be more or less direct relation between restlessness and a state of hunger or thrist. Feeding and watering invariably put an end to the aimless wanderings, the birds assuming the sleeplike attitude so characteristic of the well-fed and watered decerebrate bird. Not infrequently these birds that have been fed and watered will arouse from lethargy, make a few restless movements, defecate, and again lapse into a somnolent attitude. Thus it appears that hunger, thirst and visceral impulses are the main factors which cause restlessness in the decerebrate bird. On the whole, birds evidence much more activity when given spacious quarters than when confined in smaller cages.

The thalamus was injured or destroyed in four birds producing such effects as were described by Rogers (1919-20). There was some variation in these birds, but he describes the picture essentially presented as follows: "The feathers lay somewhat against the body, instead of fluffed; no spontaneous

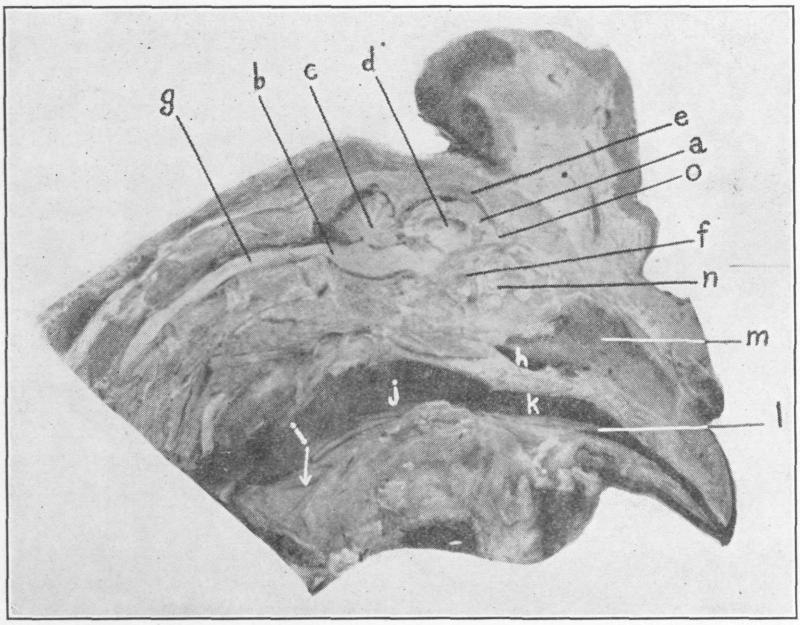

FIG. 1. Sagittal Section of the Head of Normal Birds.

a, cerebrum; b, medulla oblongata; c, cerebellum; d, lateral ventricle; e, dura mater; f, optic nerve; g, portion of cervical part of spinal cord; h, nasal cavity; i, arrow points to laryngeal opening; j, pharynx; k, oral cavity; l, tongue; m, septum nasi; n, medial portion of eye; o, olfactory bulb.

movements were made; body temperature was subnormal in three of the birds; stasis of food in the digestive tract; weakness; mucous membranes cyanotic; resting on tail feathers. Death followed in two or three days."

AUTOPSY OF DECEREBRATE BIRDS.

After the observations were made the decerebrate birds were embalmed with a 15% solution of formaldehyde, this being introduced into the left or right jugular vein, using a sixteen gauge needle and a 30 cc. syringe. The digestive tract and general condition of the birds were observed during post mortem. The heads were severed, placed in a solution of

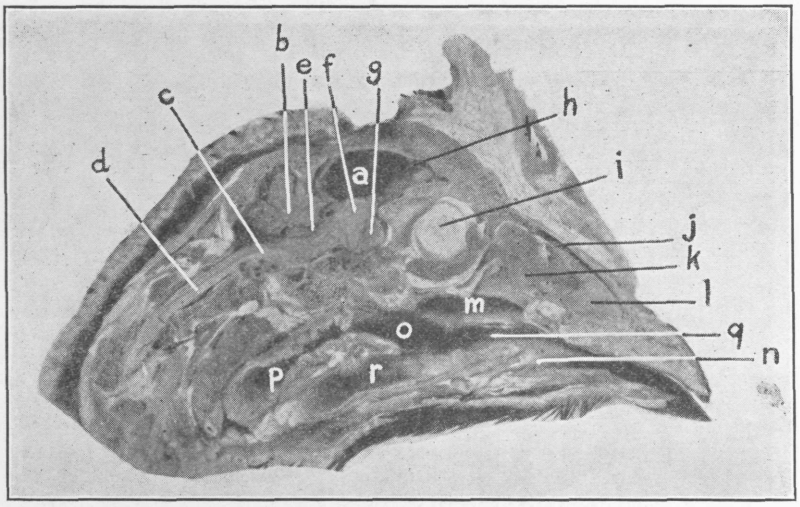

FIG. 2. Sagittal Section of the Head of Decerebrate Bird.

a, cerebral cavity; b, cerebellum; c, medulla oblongata; d, portion of cervical part of spinal cord; e, fourth ventricle; f, thalamus; g, optic nerve; h, dura mater; i, medial portion of eyeball; j, dorsal meatus; k, nasal septum; l, turbinate bone; m, posterior part of nasal cavity; n, tongue; o, pharynx; p, esophagus; q, oral cavity; r, larynx cranialis.

fuming nitric acid, one part of nitric acid to ten parts of water, and allowed to decalcify. In about ten days, the heads were sectioned and examined to determine definitely the areas of the brain tissue that had been extirpated. Figure I shows a saggital section of the head of a normal bird, while Figure II shows a section through the head of a decerebrate bird. The cavity enclosed by the dura mater in Figure II was filled with clear cerebral fluid, this cavity communicating with the third ventricle by way of the inter-ventricular foramen.

In the birds that showed typical decerebrate attitude, it was found that the cerebral hemispheres were entirely removed, with the exception of small areas which had no connection with the brain stem. In other birds that gave evidence of only partial decerebration there were found variable quantities of cerebral cortex, apparently uninjured. The connections with the brain stem appeared to be undisturbed. Those birds that could eat and drink showed only a partial removal of the corpora striata.

SUMMARY.

1. In decerebration of the fowl care must be taken to prevent severe hemorrhage.

2. Leaving the dura mater and skin unsutured relieves pressure on the vital centers.

3. Fowls were completely decerebrated and kept in health for periods varying from two to eight months, there seems to be reason to believe that this time could be extended indefinitely.

4. The behavior of decerebrate fowls closely follows that of the decerebrate pigeon.

5. Birds which regain complex reflexes of eating and drinking showed the corpora striata intact.

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